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INCREASED FEELINGS OF THE SENSED PRESENCE AND INCREASED GEOMAGNETIC ACTIVITY AT THE TIME OF THE EXPERIENCE DURING EXPOSURES TO TRANSCEREBRAL WEAK COMPLEX MAGNETIC FIELDS

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In 2 separate experiments involving 39 subjects the incidence of sensing a presence or Sentient Being while being exposed to weak complex magnetic fields over the right hemisphere was moderately correlated with increased global geomagnetic activity during the 3-h periods of the experiences. Analyses of magnetometer values near the laboratory indicated the intensity of the east-west component of the geomagnetic field had been increasing consistently at about 1 pT/s for at least 10 min for a cumulative change of about 15 to 20 nT. The ratios of the durations of alpha rhythms over the temporal lobes compared to the occipital lobes were correlated significantly with both increased geomagnetic activity and the reports of a presence. Removal of the shared variance between the sensed presence and various psychometric inferences of temporal lobe sensitivity and the history of dissociation increased and decreased, respectively, the strength of the partial correlations between geomagnetic activity and the reports of a sensed presence. The results suggest the culturally and historically ubiquitous phenomena of sensed presences are generated by right

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hemispheric processes that once enhanced by a variety of stimuli, including weak complex magnetic fields, can be encouraged by increased global geomagnetic activity.

Keywords alpha rhythms, geomagnetic activity, hemispheres, human, magnetic fields, sensed presence, temporal lobes

INTRODUCTION

Increases in geomagnetic activity have been associated with increased numbers of epileptic seizures in patients diagnosed as partial complex epileptics with foci in the temporal lobes (Rajaram & Mitra, 1981). Apparitions were also more likely to have been reported to occur during periods of increased global geomagnetic activity (Persinger, 1988; Randall & Randall, 1991). Similar experiences, those accompanying the feeling of a sensed presence, can be evoked by surgical stimulation of the mesiobasal and cortical regions of the temporal lobes (Horowitz & Adams, 1970). These phenomena are more common when these structures within the right hemisphere relative to the left hemisphere are involved. This pattern is consistent with recent observations of Kurup and Kurup (2003) who found that the chemical profiles in chronic, spiritually inclined individuals correlated with right hemispheric dominance.

Converging evidence suggests that the right hemisphere of the normal human brain may be more sensitive to changes in geomagnetic activity. For example, during the early phases of a geomagnetic storm the left peripheral visual field, typical of right hemispheric activation, was more affected than the right (Belisheva et al., 1995). If processes within the right hemisphere are more sensitive to the information contained within periods of increased geomagnetic activity, then phenomena strongly associated with its function should be more prominent during these periods. One powerful phenomenological theme associated with right hemispheric activation is the feeling of "another" or Sentient Being sharing both space and time with the experient (Bancaud et al., 1994; Persinger, 2002). This article reports here that the experiences of a sensed presence within an experimental setting were associated with concurrent, increasing geomagnetic activity.

The sense or feeling of a Sentient Being proximal or interacting with the experient's thoughts or sense of self has been reported in many cultures throughout recorded history (Evans, 1984). These intraself communions with what is perceived as extrapersonal beings have been attributed to spirits, gods, and more recently other-dimensional or extraterrestrial intelligences (Persinger, 2003). These persistent phenomena, more frequently reported by

creative individuals such as artists, writers, and musicians, may have been the bases for the Muses described by the Ancient Greeks as the source of "extraindividual" knowledge (Persinger & Makarec, 1992). Neurogenic explanations have ranged from the bicameral mind (Jaynes, 1976) that coincided with the beginning of modern human civilization to the type of parasitic or double consciousness (Bancaud et al., 1994) that occurs frequently in the experiences of patients with partial complex epilepsy.

The present authors (Persinger, 2003; Persinger & Makarec, 1992) have suggested that the experience of a proximal Sentient Being is the transient awareness of the right hemispheric equivalent of the left hemispheric sense of self when the former processes intercalate with the concurrent "self awareness" associated with left-hemispheric activity (Silberman & Weingarten, 1986). The model (Persinger, 1993) is based on three assumptions. First, the sense of self and awareness are emergent properties of linguistic processes within the left hemisphere in most people. Second, there is an equivalence or analogue of this sense of self generated within the right hemisphere whose characteristics, such as profound affect and expansiveness in space–time, reflect the functions of that hemisphere. Third, interhemispheric inhibition prevents the constant or repeated awareness of the right hemispheric equivalent during the waking state unless neuroelectrical (or neurochemical) conditions arise that facilitate its representation (and hence awareness) within left hemispheric processes.

Experiments (Persinger & Healey, 2003) designed to stimulate the right temporoparietal regions with weak (microTesla) magnetic fields for 15 min followed by 15 min of bilateral stimulation to encourage brief periods of interhemispheric intercalation have produced reported experiences of sensed presences in about 80% of participants (Persinger, 2002). Many of these experiences appear to be the result of dynamic interactions between ongoing cognition and the applied magnetic fields. For example, when the person attends to "where" the presence is located (i.e., there is a change in the configuration of brain activity), the presence appears to "move." During the pursuit of these studies it was observed that these reports were more frequent if there were increases in global geomagnetic activity at the time of the experiments. The present study explored the intricacies of this relationship.

MATERIALS AND METHODS

Subjects

A total of 39 men and women (23 in Experiment I and 16 in Experiment II), between 18 and 24 years of age, volunteered as subjects. They were enrolled

in first year university psychology courses and received two bonus marks for participation.

General Procedure

All subjects were singly tested. Each subject sat facing *eastward* within a comfortable chair that was housed within an acoustic chamber. After a blindfold had been placed over the subject's eyes, a modified motorcycle helmet was placed over the head (Persinger, 1999). The complex magnetic fields were delivered through four sets of solenoids that were embedded on each side of the helmet. The commutator was set to deliver the fields to each opposed pairs of solenoids for 0.5 s. The field was spatially rotated through the four pairs of solenoids once every 2 s.

The specific patterns of magnetic fields were generated by transforming a column of numbers between 0 and 255 to equivalent voltages between –5 and +5 V. These fixed, computer-generated numbers were then transformed to the appropriate voltages by a specialized digital-to-analogue converter that generated the current within the solenoids. The strengths (root mean square) of the magnetic fields along the inside of the helmet between the axes produced by the sets of solenoids were about 1 to 2 microTesla. The application of the field was modulated by a series of switches on the helmet that produced slightly (by about 10 to 30%) stronger fields over the *right* hemisphere compared to the left.

This slight enhancement over the right hemisphere has been associated with increased scores for suggestibility (Healey et al., 1996) during which time the "hidden observer" (Hilgard, 1984), an alleged right hemispheric process, becomes more dominant. Under double blind conditions, the subjects who were exposed to the burst-firing pattern presented over both hemispheres or the right hemisphere reported more sensed presences than those exposed to the sham-field or to left hemispheric presentations. Subjects in the latter condition reported fewer sensed presences than the sham-field controls.

Each subject was exposed to the experimental treatment for 30 min. During the exposure the subject sat within the darkened chamber. A lapel microphone was employed to record any comments reported by the subject and to allow termination of the experiment if requested. At the end of the experiment the chamber lights were lit dimly so the subject could read an exit questionnaire composed of questions that included the items referring to the incidence of dizziness, feeling a Sentient Being was nearby (sensed presence), tingling sensations, pleasant vibrations through the body, detachment

from the body, anger, sadness, terror or fear, thoughts from childhood, images from a dream, and whether or not images were along the left or right side of the visual field or body. The values for the rankings for each item were 0, no experience, 1, occasional experiences, and 2, frequent experiences. Upon completion of the questionnaire, the equipment was removed.

GLOBAL GEOMAGNETIC DATA. Geomagnetic data were obtained from Jan Alvestad's Solar and Geomagnetic Data (http://www.dxlc.com/solar/index.html). The first measure was the 3-h planetary k (kp) values (Campbell, 1997). They were a series of integers, potentially between 0 and 9, that reflected quasilog values for the intensity of geomagnetic activity; 3-h values, adjusted to local time, were obtained for each of the 3-h intervals during, before, and after the experiment. The A values (average of the low and high value for the daily, global A values) were also obtained for the day before, the day of, and the day after the experiments. When multiplied by approximately 2 they yield values similar to the aa (average antipodal) index expressed in nanoTeslas.

LOCAL GEOMAGNETIC DATA. To verify the local validity of the global geomagnetic indices daily records from our MEDA FM-300 magnetometer for the X (N-S), Y (E-W), and Z (vertical) components were extracted from our database. These values had been recorded every 24 s by a laptop computer and stored on diskettes. The sensor, located about 50 m from the chamber, had been operating for 10 of the nights in which the subjects were tested in Experiment I. The direction and maximum change in the intensities for each of these spatial orientations were measured manually for the local 3-h intervals in which the experiments occurred (7 p.m. to 10 p.m.) as well as the 3-h intervals preceding these periods (4 p.m. to 7:00 p.m.). These values, in nanoTeslas, were correlated by Spearman rho and Pearson r with the k-values for these two periods.

EXPERIMENT I. These subjects had volunteered to participate in a relaxation study during which time they were told they may or may not be exposed to weak magnetic fields. However there was no reference to the sensed presence as the primary focus of the experiment. Silver-silver electroencephalographic sensors were placed over the frontal (F7,F8), temporal (T3,T4), and occipital (O1,O2) regions. During the experimental period bipolar activity was recorded by a P79 Grass electroencephalograph. Forty-second increments (2 consecutive 20 s sheets) were selected from the first 5 min, middle 5 min, and last 5 min of the exposure period. The proportion of alpha rhythms, defined as the numbers of seconds containing clear 8–13 Hz rhythmic activity,

were measured manually for each of the three increments for each of the three channels (frontal, temporal, and occipital lobes).

The subjects were exposed to either 5-Hz sine waves, 40 Hz-sine waves, or 40-Hz sine waves that were phase-modulated 5 times per second. They had been selected because of their relevance to the frequencies associated with the phase shifts and integrations of electroencephalographic activity that are generated recursively in a rostral-to-caudal direction over the cerebral cortical manifold every 10 ms to 20 ms and are presumably associated with the creation of consciousness (Llinas & Pare, 1991). Because there were no significant differences between the incidence of the sensed presences or the strengths of the correlations between the concurrent geomagnetic activity and the sensed presence for subjects that had been randomly assigned to these three treatments, the groups were pooled for the final analyses.

The means of the three measures for the proportion of alpha rhythms were calculated for each channel to yield one score for the frontal, temporal, and occipital lobes. Because the ratios of alpha rhythms over the temporal lobes relative to the occipital lobes have been shown to be a more specific indicator of behavioral correlates of temporal lobe activity (Makarec & Persinger, 1990), this value was calculated as well. These values were correlated with the 24-h values for the geomagnetic activity for the day before, the day of, and the day after the experiment as well as with the 3-h kp values for the period during, before, and after the experiments. Both sets of these values were correlated with the incidence of the sensed presence.

Experiment II. Each subject was told that the purpose of the experiment was to discern if specific types of magnetic fields could affect the occurrence of a sensed presence. It was defined as the feeling that a Sentient Being was standing near the person while they were sitting, blindfolded within the darkened chamber. During the 30-min period the subjects were exposed successively, in different orders, to six different patterns of magnetic fields. Each pattern was presented for 5 min.

The subject was requested to move his or her left or right finger (each of which was connected to electrodes leading to different electroencephalographic channels) to indicate when a presence occurred on the left or right side of the body. The results of this study have been reported elsewhere (Booth et al., 2003). The proportions of sensed presences and other experiences, as indicated by the exit questionnaire, were then correlated with the kp values and 24-h A values.

These subjects also had scores from relevant questionnaires collected

about two months earlier as a routine component of course requirements. The data were obtained to discern the potential psychometric sources for the relationship between geomagnetic activity and the sensed presence. Each subject's scores for the Wilson–Barber Scale of Imaginings (Wilson & Barber, 1983), the Dissociative Experience Scale (Bernstein & Putnam, 1986), and the Temporal Lobe Sensitivity Scale (Persinger & Makarec, 1993) were employed in partial correlation analyses. The titles of the tests reflected their constructs: the capacity to fantasize or imagine, the incidence of dissociation (non-awareness of self activities) and temporal lobe sensitivity (the types of ictal and interictal experiences reported by individuals with diagnosis of complex partial epilepsy). All analyses involved SPSS software on a Vax computer.

RESULTS

The Spearman rho correlations between the incidence of the various experiences and the geomagnetic activity, as inferred by the planetary k (kp) value during the 3-h periods of the experiments and the mean A values for the 24-h periods on the days of the experiments, are shown in Table 1 for Experiments

Table 1. Spearman rho correlation coefficients between the relative frequency of various experiences and geomagnetic activity during the 24-h period or the 3-h period of the 30 min experimental field exposures

	Geomagnetic activity			
	Experiment 1 (n = 23)		Experiment 2 (n = 16)	
Experience	3-h	24-h	3-h	24-h
1. Dizzy	.28	.39*	.49*	.26
2. Presence	.48**	.45*	.49*	.38
3. Tingling sensations	.44**	.35*	−.08	−.23
4. Pleasant vibrations	.18	−.02	−.40	.00
5. Detached from body	.26	.35	.44*	−.04
6. Anger	.34*	.03	−.35	−.24
7. Sadness	.38*	.31	−.05	.50**
8. Terror or fear	.19	.22	.18	−.02
9. Thoughts from childhood	.10	−.03	−.11	.05
10. Images from dreams	.17	−.09	.22	−.19
11. Images along left side	.49*	.47*	.09	.39*
12. Images along right side	.03	−.16	−.12	−.20

*$p < .05$; **$p < .01$.

I and II. There were moderate strength correlations (rhos 0.40) between the numbers of presences during the 30 min experimental period and intensity of geomagnetic activity (Table 2). Values for Pearson correlations (r) were comparable in magnitude and statistically significant. The second most consistent correlation in both studies was the greater incidence of reported visual sensations along the left visual fields but not the right visual fields during the experimental stimulation and increased geomagnetic activity.

The correlations (Spearman rho and Pearson r, respectively) between the kp values during the 3-h interval associated with the experiments and the various intensities of the components for the magnetometer were east–west (Y) direction (.95, .84), north–south (X) direction (.62, .64), and vertical (Z) direction (.86, .69). All correlations were significant statistically ($p < .01$). Spearman rho correlations between the kp values and the slope of the change for each component were: east–west .84 ($p < .001$), north-south .57 ($p < .05$), and vertical .12 (n.s.). The range of the intensity of the maximum changes during the 3-h periods within which the experiments occurred for the various components were 10 to 140 nT for the east-west direction, 10 to 170 nT for the north-south direction and 10 to 260 nT for the vertical direction.

Experiment I

GLOBAL GEOMAGNETIC DATA. Partial correlation analyses indicated that when the shared variance between the activity during the 24-h interval and the 3-h

Table 2. Means and standard deviations for the indices of geomagnetic activity for the periods before, during, and after the experiments

	Experiment I			Experiment II		
	M	*SD*	Pres rho	*M*	*SD*	Pres rho
A values						
Day before	18.7	7.9	.07	16.3	6.5	−.08
Day of	18.6	7.4	.45**	15.8	4.9	.37
Day after	16.6	6.4	.25	19.5	7.0	.22
3-h Kp values						
Before	2.9	.5	.32	2.7	.5	.00
During	2.7	.9	.43*	3.2	.8	.49**
After	3.0	1.0	.32	2.9	1.1	.24

Spearman rho correlation coefficients between the incidence of sensed presences in the experimental setting and the environmental indices are also shown.

*$p < .05$; **$p < .01$.

interval during which the experience occurred was removed, the correlation between the numbers of presences and the 3-h kp values was no longer statistically significant [partial r(18) = .24]. Similarly, the partial correlation between numbers of presences and the 24-h values were no longer significant (partial r(18) = .20) when the shared variance between the 24-h values and the concurrent 3-h k values was first removed.

LOCAL GEOMAGNETIC DATA. The maximum change in activity in nT during the 3-h intervals of the experiment was significantly [$F(1,8) = 17.89$, $p < .01$; eta-squared = 67%] greater for the vertical component (M = 160 nT, SD = 78 nT) for the subjects who reported a sensed presence compared to those who did not (M = 25 nT, SD = 15 nT). Except for the significantly greater activity in the north–south direction during the 3-h period before the experiments began for the subjects who reported a presence compared to those who did not [$F(1, 8) = 8.43$, $p < .05$; eta-squared = 54%], no other differences between the times associated with reporting or not reporting a sensed presence were significant statistically for either of the 2 adjacent 3-h intervals.

Partial correlation analyses between the numbers of sensed presences for the 10 subjects (4 reported yes, 6 reported no) who were tested when the magnetometer was in operation showed that the intensity of the north–south, east–west, and vertical components were differentially important. After the shared variance with each of the other two components had been removed only the correlations between the report of a presence and the intensity of the vertical component remained statistically significant (.81 and .72, respectively).

Interestingly, when the shared variances between the activity within the north–south component between the two 3-h intervals of and before the experiences were removed, the positive association between the increased activity in the north–south component during the time of testing and the incidence of the presences was significant (partial r = .62, $p = .05$). Removal of this shared variance eliminated the statistically significant zero-order correlation between the incidence of the sensed presences and activity during the previous 3-h interval (partial r = .25). The correlation between the incidence of presences and activity in the vertical component remained significant (partial r =.82) even when the shared variance with the previous 3-h interval was removed. However, the partial correlation between the experiences and the activity during the *previous* interval became significant (partial r = –.68, $p < .05$) when the shared variance associated with experimental interval was first removed.

In all of the periods in which the subjects reported a sensed presence the slope within the east–west component was positive and continuous. Within the limits of measurement error, the duration of the progressive and consistent increase in intensity was between 12 and 15 min with a rate of approximately 15 to 20 nT/10 min. This increase occurred in only 17% of the subjects who reported no sensed presence [$F(1, 8) = 16.00$, $p < .01$]. There were no statistically significant differences in the slopes of the changes (for subjects who reported or who did not report a sensed presence) in either the north–south or vertical components during this 3-h period or for any of the three components during the 3-h period [F(all dfs = 1,8) <1.00, $p > .05$] before the experiments began.

ELECTROENCEPHALOGRAPHIC CORRELATES. As shown in Table 3, there was a statistically significant positive association between the incidence of a sensed presence during the experiment and the ratio of durations of alpha rhythms over the temporal lobes relative to the occipital lobes for the subjects. A weak positive correlation was evident between the geomagnetic activity at the time of the experience and the proportion of alpha rhythms over the temporal lobes only. A priori removal of the shared variance between the 3-h kp values for the period of the experiments and either the proportions of

Table 3. Means and standard deviations (*SD*) for the proportions of alpha rhythms over the prefrontal, temporal and occipital lobes, the incidences of sensed presence within the experimental setting, and the various indices of geomagnetic activity

			Spearman rho correlations	
Variables	*M*	*SD*	Presence	3-h kp
Frontal alpha	1%	2%	.05	.16
Temporal alpha	16%	22%	.10	.36*
Occipital alpha	22%	26%	−.29	.01
Temporal/occipital Alpha	1.3	1.2	.45**	.30
Presence	.4	.6	—	.48**
3-h K value 2	.9	.5	.48**	—
A value (day before)	18.7	7.8	.07	.10
A value (day of)	18.6	7.4	.45**	.58**

Correlations (rho) with each of the variables and the incidence of sensed presences and geomagnetic activity during the periods of the experiments are also shown.

*$p < .05$; **$p < .01$.

alpha rhythms over temporal lobes or the ratio of alpha rhythms over the temporal/occipital lobes eliminated the significant correlations between the incidence of a sensed presence and either measure of electroencephalographic activity. The association between the incidence of a sensed presence and concurrent geomagnetic activity remained statistically significant (partial r = .37, $p < .05$) even when the shared variance with alpha activity was first removed.

Except for the significant correlation between proportions of alpha rhythms over the occipital region and the amount of geomagnetic activity during the 24-h period the day *before* the experiments, there were no other statistically significant correlations between the electroencephalographic measures or the inferences of sensed presences and geomagnetic activity.

Experiment II

The partial correlation between the numbers of presences and the concurrent 3-h geomagnetic activity was still significant (partial r = .48, $p < .05$) even after the shared variance with the activity of the entire 24-h period was first removed. The converse, removal of the shared variance between the 3-h interval and the 24-h, eliminated the statistically significant association between numbers of presences and the activity during the entire 24-h period (partial r = –.09, n.s.). Removal of the shared variance between the 3-h periods of the experiences and the 3-h periods before or after the experiences did not appreciably change the former's correlation with numbers of sensed presences (partial rs = .52, .51, respectively, $p < .05$).

The strength of the statistical significance for the partial correlation coefficient between the concurrent 3-h geomagnetic activity and the numbers of sensed presences increased if the shared variance with scores for temporal lobe sensitivity (partial r = .64, $p < .01$) was first removed. A priori removal of the subjects capacity to dissociate, as inferred from the Dissociative Experience Questionnaire, reduced the statistical significance of the association between sensed presences and concurrent geomagnetic activity (partial r = .40, $.05 < p < .10$). Pre-removal of the shared variance between the capacity to imagine, as inferred by the Wilson–Barber Imaginings scale, did not change the level of statistical significance (partial r = .47, $p < .05$). Similar effects were found with these measures for the relative incidence of sensed presences that had been calculated by dividing the score for sensed presence by the mean score for all experiences reported on the exit questionnaire.

DISCUSSION

Experiences for brief periods of the "felt" presence of another consciousness juxtaposed on or adjacent to the awareness of the experient have been reported by human beings for thousands of years. The phenomena appear to extend beyond the space and time occupied by the experient and are frequently described by words such as infinite or eternal (Persinger, 1993, 2003). The experiences are often so meaningful that a single episode can modify the experient's behavior indefinitely, particularly if it is concomitant with activation of auditory (a voice) or visual (a vision) modalities. The experiences have been attributed to extracorporeal beings, spirits, and gods (Evans, 1984) whose origins reflect the fundamental beliefs defining the culture and the person.

The authors (Persinger, 1993) have been pursuing the hypothesis that the experimental production of a sensed presence, this relatively common feeling of "another Sentient Being," is the prototype for a divergent cluster of phenomena whose attributions have ranged from spirit guides in non-Western cultures to angels in Western culture. If structure dictates function, then the fact that all human brains are each composed of two hemispheres with a plethora of slight but significant differences in micromorphology (van Essen & Drury, 1997) predicts the existence of two sources of variance that are the infrastructures for two types of "awareness" or "consciousness." One type would involve the usual left hemispheric, self-oriented form dominated by linguistic concepts and categorical thinking whereas the other would be characterized by the more "parasitic consciousness." The characteristics of this "other consciousness" would reflect the more distinct functions of the right hemisphere, which include emphases on spatial, intuitive, gestalt, emotional, diffuse, and simultaneous processes (Budzynski, 1986).

The hypothesis assumes normal interhemispheric inhibition prevents the continuous occurrence of these experiences except during specific states. They would allow the intermittent or "statistical" intrusions of this equivalent of the sense of self into awareness. The fast, more immediate intrusions dominated by visual imagery and complex cognitions might occur through the corpus callosum (Schuz & Preissel, 1996). Additional intrusion within similar time-frames mediated through the functional corpus callosum for the ventral volume of the temporal lobes, the anterior commissure (Di Virgilio et al., 1999), would be dominated by sudden emotions or affects such as rapture, ecstasy, or profound terror. Slower mediation through the dorsal hippocampal commissure (Gloor et al., 1993), which interconnects the entorhinal cortices

and hippocampal formation of the two hemispheres, might promote *alterations* or modifications in the consolidations of experiences. They would affect the content of the details of declarative memory when it is reconstructed days to weeks later. In conjunction with the person's attributions of the experience, these alterations could change the person's autobiographical memory, a process strongly affected by right prefrontal functions (Buckner & Petersen, 1996), for the details and context of the original event.

According to the vectorial hemisphericity hypothesis (Persinger, 1993), the sensed presence can be considered the transient awareness of the right hemispheric equivalent of the left hemispheric sense of self. Conditions that increase the likelihood of diminishing the normal interhemispheric inhibition, such as hypervigilance, dreaming, personal (identity) crisis, or a history of mild brain injury within the right hemisphere, promote the incidence of experiencing an occasional sensed presence during transition states in consciousness. The results from the authors' experiments indicate that increases in geomagnetic activity, by influencing the right hemisphere, increased the likelihood of reporting a sensed presence during a 30 min exposure to the experimental setting.

They have found that exposures of about 10 to 15 min to experimentally generated burst-patterned 10 nT to 1 microT magnetic fields generated with about 10% greater intensities over the right hemisphere compared to the left hemisphere of subjects are usually required to induce the first report of a series of sensed presences compared to sham-field controls. Once the first response occurs latencies to subsequent changes in field patterns, unknown to the subjects, are within about 1 min. It had been assumed that the initial latency of the order of about 10^3 s was related to the time required to synchronize a "critical mass" of neurons that would be sufficient to overcome interhemispheric inhibition and allow their information to cross into left hemispheric processing and hence awareness. This process is assumed to occur with the recruitment of many microparoxysmal processes until a threshold is achieved for the emergence of qualitatively different phenomena within larger increments of space and larger intervals of time within the brain (Goldensohn, 1983).

The results of the two experiments indicated that the relative incidences of sensed presences during applications of relatively stronger complex magnetic fields over the *right* hemisphere were greater if geomagnetic activity, as defined by the planetary k-index, had increased at the time of the experiences. The strengths of the correlations ranged between .38 and .49. Although the subjects in Experiment 2 were told to respond to sensed presences

if they occurred, the strength of the association between the concurrent geomagnetic activity and the relative incidence of these experiences of a Sentient Being near the experient within the chamber was comparable to those reported by the participants in Experiment 1 who were focusing on relaxation and had not been exposed to this expectancy.

That a right hemispheric sensitivity to increased geomagnetic activity occurred in the present subjects was shown by the statistically significant positive correlation between the geomagnetic values at the time of the sensed presences within the chamber and the predominance of visual sensations along the *left* side but not the right side of the experients' visual fields. There was no significant association between the occurrence of visual sensations along the left visual field and the report of a presence. This may reflect general activation of large areas of the right hemisphere where occipital stimulation produces "visual" effects and temporoparietal stimulation results in the sensed presence.

Previous studies have reported statistically significant correlations between the epidemiological occurrences of apparitions and other sensed presences and increased geomagnetic activity (Persinger, 1988). The average value for global geomagnetic activity on these days was about 20 nT higher than the days before or after the experiences. Because the daily averages for global aa values are strongly influenced by the most disturbed component of the magnetogram, one would expect that a significant proportion of daily aa values, especially during periods when "minor" or "brief" increases in geomagnetic activity were more likely, to have been dominated by the changes within the most active 3-h period.

This relationship may explain why the spontaneous incidence of sensed presences are often correlated with geomagnetic activity of both the 24-h period and the 3-h period in which the experiences are reported and suggests that the actual correlational strength of the relationship between the experiences of "spontaneous" presences in the general population and concurrent geomagnetic activity may be significantly *underestimated.* These data were obtained from reports of "spontaneous experiences" that occurred nocturnally between the years 1870 and 1970 outside of the laboratory (Persinger, 1988). The diurnal variation with peaks between 2 h and 6 h was consistent with the likely protrusion of REM (rapid eye movement) processes (dreams) into waking awareness. These nocturnal states are usually suppressed by melatonin (Goldstein & Pavel, 1981). Decreased levels of nocturnal melatonin in response to increases in global geomagnetic activity (Burch et al., 1999) would encourage these intrusions. The results of the present study also indi-

cated that reports of sensed presences within the quiet, darkened laboratory under optimal conditions are correlated significantly with increased global geomagnetic activity.

The utility of employing this general global index for studying reports of sensed presences within various localities was supported by the strong correlation between the global values and the local geomagnetic activity (at least in the author's laboratory) as well as by the correlation between values from both sources of measurement and the incidence of sensed presences. The primary interval of analysis was the 3-h period that included the times of the exposures of the subjects to the experimental magnetic fields. Data from the local magnetometer near the laboratory that was operating at the time 10 of the subjects were tested showed the strongest correlate between the experience of a presence and geomagnetic activity involved the vertical (z) component; it displayed scalar values that were four times that of either the north–south or east–west components. The sensed presences occurred when there was increased activity within this direction, especially compared to the previous 3-h interval.

However, once the shared variances had been accommodated the incidence of a sensed presence increased with greater activity within the east–west component during the specific 30 min experimental periods. The subjects in this study were sitting in a comfortable chair and facing an east–west direction. This orientation may be important. Collection of reports concerning the sensed presence, often attributed to psi phenomena, have shown a weak propensity for an east–west spatial orientation between the experient and the person (the "agent") attributed as the source of the "unusual" feeling (Persinger, 1974).

The results of the present studies expand the understanding of the relationships between brain activity, the sensed presence, and ambient geomagnetic activity. First, the elimination of the statistically significant correlation between the proportion of alpha rhythms over the temporal lobes and the sensed presence (once their shared variance with ambient geomagnetic activity had been removed) suggests that fluctuations in geomagnetic activity may have been responsible for both the experiences of a presence and the increased proportion of alpha rhythms over the temporal lobes. This association does not imply that all alpha activity is due to geomagnetic activity. Because electroencephalographic activity is a gross measure of the summated potential differences generated by millions of cerebral cortical neurons these correlations between global indices of geomagnetic activity and proportions of alpha-rhythms indicate some component of geomagnetic activity or some

factor associated with this component must affect either very large numbers of neurons or the processes that control their aggregate activity.

The correlation between the duration of alpha rhythms over the temporal lobes (Makarec & Persinger, 1990) and the occurrence of sensed presences supports the authors' previous hypothesis that the sensed presence is related to temporal lobe functions (Persinger, 1993). There are multiple variants of alpha rhythms generated from multiple intracerebral sources with a slight dominance in the right caudal hemisphere (Niedermeyer & Lopes·da Silva, 1987), some of which occur briefly during periods of dreaming whose cognitive correlates can protrude into the waking state. These oscillations occur as stable spatial distributions of potentials, lasting for variable numbers of milliseconds, that define the microstates (Cantero et al., 2002) with which the applied experimental or the geomagnetic field might interact.

If REM-alpha bursts are functionally brief temporal windows during which time the brain is highly susceptible to processing external sensory information (Cantero et al., 2002), then the association between the increased geomagnetic activity and the ratio of temporal/occipital alpha rhythms might reflect access to stimuli to which the person might not normally respond. This information would then be translated into the categorical language of left hemispheric function. The fidelity of this translation would determine the accuracy. Because of the micromorphological differences that define the two hemispheres and their functions (van Essen & Drury, 1997), the translation of the complete sequence could never be exact. According to Schneidman et al. (2003) decoding fundamentally requires a measurement of error that quantifies the meaning of the deviations of the estimated stimuli from the actual stimuli.

The specific experience of a sensed presence has been associated with a history of more general experiences associated with increased activity within the temporal lobes (Persinger & Makarec, 1993). In the present study when the shared variance between the subjects' scores for general temporal lobe sensitivity, the sensed presence, and geomagnetic activity was first removed, the strength of the correlation between increased ambient geomagnetic activity and the occurrence of a sensed presence actually *increased.* This enhancement suggests that processes controlling the association between increased geomagnetic activity and experiences of sensed presences within the experimental setting can be amplified once the intrinsic "noise" from individual differences in temporal lobe sensitivity, which might statistically generate these common experiences, is removed.

However, the strength of the association between the sensed presence and concurrent geomagnetic activity was reduced when the subjects' scores for

dissociation were accommodated. People with higher dissociative scores are prone to greater periods of suspension of left hemispheric activity (awareness) and more frequent intrusions from right hemispheric experiences. The recent measurements (Yazici & Kostakoglu, 1998) of reduced metabolic activity in the left hemisphere (and hence more relative right hemispheric dominance) in patients with diagnosis of dissociation and conversion disorder supports this interpretation of psychometric results. It may be relevant that the symptoms of "electric shocks," paraesthesias and epigastric or olfactory, frequent reports during right hemispheric stimulation by the experimental fields, have been reported in patients diagnosed with both dissociative disorders and complex partial epilepsy (Devinsky et al., 1989).

The experiments involving the application of weak, complex magnetic fields through the brain have been designed to test two models. The first assumes the experience of a sensed presence occurs when right hemispheric input reaches a critical mass during the waking state and intrudes into left hemispheric awareness. The second model assumes that the optimal spatial and temporal superimpositions of a complex magnetic field on the neuro-processes generating consciousness result in a simultaneous "doubling" of the experience of self. This process, metaphorically, could be similar to the Zeeman effect where the application of a static magnetic field splits the emission and absorption spectrum of the constituents of the matter into equally polarized components when the source is observed parallel to the field.

Zeeman effects are determined by the dependence of the energies of individual electrons on their inclination to the direction of the magnetic field. The requirements of quantum energy impose conditions such that the plane of an electron's orbit can only occur at certain definite angles to the applied field. Classical interpretation requires moderately strong magnetic fields to produce the condition where the precession of the inter-electron orbital angular momentums and the spin angular momentums are faster than the total precession around the field. It may be relevant that when the source is viewed at right angles to the field a third component emerges that has the same frequency as the undisplaced spectral line. From a quantum perspective, each line presumably corresponds to an atomic transition from one specific discrete state to another defined by an angular momentum that is split into substrates of equal energy separation by a magnetic field.

If this transient "doubling" was manifested within the organization of matter from which consciousness is generated during a specific derivative and vector (direction and magnitude) of geomagnetic activity, then the possibility for entanglement of the two states (Aczel, 2002) might also occur.

When a similar geomagnetic condition occurred during a later time within the same space, the memories and experiences ("images") associated with the initial "splitting" could be reconstructed within the same geomagnetic space. This process might be analogous to the production of a "geomagnetic-neuroelectromagnetic" hologram (Bentov, 1977).

The "quantal" entanglement might allow access to information from this previous state of consciousness (Jibu & Yasue, 1995) even though the brain structures from which it was generated were no longer organized or active. Attempts to translate quantum physics into information theory have been more effective, particularly for Heisenberg phenomena (Cramer, 1997; Horgan, 1982). When applied to the present context, the only discernable experiences should be the *information* that was being displayed during the approximately 30 min of the electrically labile phase of memory consolidation at the time of the transitory, geomagnetic field-induced "doubling" of consciousness. Information that had been translated to the microspatial (non-electromagnetic) representation of dendritic spines would not be accessible.

The capacity to dissociate or to display relatively elevated right hemispheric dominance may facilitate the conditions that either allow the brain to detect and to respond to increased geomagnetic activity or to be aware of the processes generated by it. If the Zeeman-like model is valid then individuals with the more polarized hemispheres, such as complex partial epileptic patients with right hemispheric foci or patients with dissociative disorders (Devinsky et al., 1989), may be more sensitive to the "splitting" of the complex atomic processes composing the matter by which or through which consciousness is generated. Shifts in the polarity over the cerebral cortices of about 50 microV can occur in normal individuals. According to Hallschmid et al. (2003) a positive shift was associated with reward typical of appetitive satiation.

The mechanisms by which the correlations between the reports of a sensed presence and kp values are mediated were not tested in this study. The concurrence between the reported sensed presence and consistent, progressive increases in intensity of about 20 nT/10 min within the east–west component of the local geomagnetic field would indicate *rates of change* or the derivative for a specific duration may be important for the production of the phenomena. The probable role of the second derivative, or the rates of rates of change, in the generation of consciousness have been discussed by several authors under the general rubric of "re-entrant" processes (Edelman, 1989; Llinas & Pare, 1991).

The actual strengths of this steady increase in the east–west component

of the geomagnetic field would be in the order of 1 to 30 pT/s. If it is assumed that the interactions between exogenous magnetic fields and neurogenic magnetic fields are analogous to the interactions between a range of concentrations of ligands and receptor subtypes within the cell membrane, then optimal "intensities of the applied field," like "optimal concentrations of ligands" with specific dissociation constants for high affinity receptors, would evoke more optimal responses. However the critical values for electromagnetic fields would be the intricacies of the *temporal structure* rather than the spatial (molecular) organization.

In an external magnetic field the axis of each electron's orbit is assumed to precess with the Larmor frequency of eB/2mc where e is the electron's charge (1.6×10^{-19} A s) and m is its mass (9.1×10^{-31} kg), B is the strength of the applied magnetic field and c is the velocity of light. This frequency may *combine* with the frequency of an optical transition (from one specific discrete state to another for an atom) to produce the Zeeman effect. The change in angular frequency associated with the applied magnetic field can be determined by [Be/4pi m]. For a static field of 7 nT (the value 7 was used to obtain an integer for the solution) the change in frequency would be 100 Hz. The values for the maximum range in classical brain frequencies would be between 70 pT and 7 nT.

These solutions suggest that the "steady state" shift in the geomagnetic intensity would encourage changes within the angular frequency of the rotation of electrons that compose at least the hydrogen atoms within brain space. Implicit with the solution is the differential effect of the plane of the orbit with respect to the angle of the functional magnetic field. If the centripetal force were partially electric and partially magnetic and the orbital radius did not change, then the angular frequency viewed by an observer sighting along the field should increase if the electron was circulating clockwise and decrease if it the electron was circulating counterclockwise.

Anninos et al. (1991) have shown that the intensity profile of the brain is within the 1 pT range. Frequency-modulated magnetic fields applied within this order of intensity over the right hemisphere or over the vertex have produced significant clinical changes within brief periods (Sandyk, 1992, 1995). If these increments per sec were considered then the values for changes in angular frequency would occur within the range of .01 Hz to 1 mHz or periods of between 1.7 min and 16 min. Interestingly, the reports of the experience of a sensed presence in the authors' studies were associated with systematic increases in intensities of about 1 pT/s for at least 10 min. Whether or not this congruence between predicted values and observed values is

spurious or suggests a critical latency for the coherence or recruitment of threshold numbers of electrons to compose this "second discrete state" must still be investigated.

Although the molecular effects of the maintained shift in the earth's magnetic field of about 20 nT would appear to be small the numbers of units influenced within the brain could be very large. If it is assumed that: (1) the classical Zeeman effect with perfect resolution of the split spectra requires exposures to field strengths of about 10^{-2} T (100 gauss) also indicates that all electron orbits within most of the members of the species generating the absorption spectra have been recruited into the doubling, and (2) lower strength magnetic fields may only affect a subset of those elements in a proportional manner, then estimates of influence might be obtained. A shift of 10^{-8} T in the geomagnetic field would affect only one out of every million elements, that is, a micromole that would still involve 10^{17} "atoms." If they maintained their capacity to store information despite the shift to a second discrete state, they might have the potential to generate the complexity (Tononi & Edelman, 1998) required for a "second consciousness."

It is suggested that the maintained shift in the intensity of a component of the earth's magnetic field might preferentially affect the right hemisphere because of its greater (by about 10% compared to the left) blood flow, volume, and myelinization. Unlike the typical left hemisphere, where functions are organized in local spaces, functions within the right hemisphere (Bear, 1986) are more diffusely represented throughout its volume (Kolb & Whishaw, 1990). The structural substrate for this "diffuseness" might allow the conditions within which the necessary coherence (McFadden, 2002; Thatcher, 1997) of electrons or specific molecules could occur as a type of condensate during whole-brain (Nunez, 1995) exposure to specific shifts in the intensity and direction of geomagnetic activity.

This suggestion that the right hemisphere (Persinger, 2001) is involved with the sensed presence and related ephemeral phenomena is not novel. According to Harrington (1995), several well-known researchers from the late nineteenth century, including Marie de Manaceine, Frederick Myers, and Cesare Lombrosos, had concluded that dreams, the "symptoms of spiritualistic phenomena" and the "subliminal self"—a type of unconscious mind with paranormal access to spiritual realms, involved the right hemisphere. In a more contemporary context the latter statement might be rephrased to state "the right hemisphere can exhibit neuroelectromagnetic organizations, like the hidden observer (Hilgard, 1984), that allow congruence with and access to the information contained within the geomagnetic field.

There may be an explanation for the apparent discrepancy between the intensities (microTesla) that were employed to reliably generate the sensed presence and those correlated with global geomagnetic activity (nanoTesla range). If a sustained increase in the steady component of the magnetic field over the right hemisphere is one important factor, then the experimental enhancement of these reports may reflect the *combination* of a shift in intensity of the "steady" background field and the applied temporally complex magnetic fields. The authors recently found this pattern in the experimental setting following more precise measurements with magnetometers.

Because of the circuitry of the solenoids on both sides of the helmet through which the magnetic fields are generated and in order to enhance the field on either the right or left side of the helmet (and hence the subject's brain), there is a steady-potential shift in the static field over the right side of the helmet when it is activated compared to the left. The difference between the left and right side is about 20 to 40 nT. This would mean that if the complex fields generated by the computer and converted to the digital-to-analogue converter were applied for 10 to 20 min over the right hemisphere there would also be a "d.c." shift resulting in approximately 20 to 40 nT increases in the steady-state magnetic field compared to baseline for this duration as well.

The sham procedure involved activating all components of the experimental conditions, except the computer program that generated the fields was not engaged. In previous experiments a small proportion of subjects exposed to sham fields have reported a sensed presence although the experiences were more vague and non-specific (Persinger & Healey, 2003). The authors had assumed this simply reflected the intrinsic characteristics of the human brain because of the moderate correlation between temporal lobe sensitivity and the experience of a presence. The measurements suggest that the sham-field groups may have been exposed to this small d.c. shift only. Interestingly, subjects in that study who were exposed to the same fields presented with an enhancement over the *left* temporoparietal region reported *no* sensed presences. The observation that relatively stronger left hemispheric stimulation was associated with no reports of sensed presences and relatively stronger right hemispheric stimulation was associated with reports of frequent sensed presences would complement the conclusions of Kurup and Kurup (2003). Their biochemical changes would be consistent with Sandyk's hypothesis (1997) that effects from applied pT magnetic fields could be mediated through the pineal-hypothalamic tract. According to Jacobson's (1994) calculations, if one employs the orbital velocity of the earth as one of the parameters in his equation, a range of cyclotron-like frequencies for magnetic

fields within the pT range would match resonance solutions for melatonin as well as a variety of proteins with specific masses.

The latency of about 5 to 10 min for the experiences to be reported following the onset of the fields would be consistent with the operation of a cumulative process. This duration also defines the twilight state of hypnagogic imagery if the person is falling asleep or of hypnopompic imagery if the person is waking up during which time the person experiences emergent dreamlike images (Budzynski, 1986). The authors have speculated that this duration is required to allow the recruitment of sufficient neuronal patterns within the right hemisphere to achieve the "critical mass" to generate the timing or strength of signals that can penetrate into the left hemisphere and hence "awareness." The concept is similar to the observation that when a sufficient number of neurons in different cortical columns fire in synchrony alpha rhythms are observed over the scalp (Connors & Amitai, 1997).

It had also been assumed that the time constant to achieve this "critical mass" would involve periods of between 5 min (3.3 mHz) and 10 min (1.6 mHz). They appear to be associated with the temporal integration of patterns of neuronal activity into the electrotonic or more "steady" state generated throughout the brain by the syncytium of glial cells (Rowland, 1968). While designing the protocols for the experimental procedures the present authors have been cognizant of the important role of the glial syncytium and its associated matrix of varying concentrations of extracelluar potassium ions and the indirect modulation of neuronal concentrations of calcium ions. Their concentrations can move large populations of neurons toward hypopolarized states that can encourage burst-firing and high-frequency oscillations within large volumes of the hippocampus and entorhinal cortices (Staba et al., 2002). These high-frequency oscillations, when a "critical mass" was achieved, could propagate information into and might also modify "awareness." Like other paroxysmal phenomena one would expect the neurogenic pattern, once the "critical mass" has been achieved, to be experienced as a "sudden intrusion" into left-hemispheric awareness.

The authors have been vigilant of potential environmental variables with which the glial syncytium might couple through resonance. It may be relevant that approximately 5-min variations (originating as heat-driven currents just beneath the sun's visible surface) occur within the solar wind. These periodicities occur within the range between 2 mHz and 125 mHz that dominate the power spectral density of geomagnetic activity (Bubenik et al., 1983). The north-south and east–west components are about 10 db stronger in this range than magnitudes associated with the z (vertical) component. Two bands,

around 3.7 mHz and 4.3 mHz, define resonant oscillations between the solid earth and the atmosphere (Nishida et al., 2000). The excitation source of these free oscillations, with amplitudes in the order of 1 nGal, may be at or just above the earth's surface and peak during the summer months when spontaneous cases of "remote viewing" are also more frequent (Persinger, 1974). It may be relevant that the difference between the required velocities for the circumference of the earth divided by the second-equivalence of 3.7 mHz (270 s) and 4.3 mHz (233 s) approaches the orbital speed of the earth within at least one relativistic time frame.

However, the reduction of the strength of the authors' effect when the person's capacity to dissociate was covaried offers another explanation for this latency. For example, the change in state or "switch process" from one "personality" to another, displayed by patients diagnosed as "multiple personalities" or dissociative disorders, requires about 5 min (Putnam, 1988). During similar altered states the person reports enhanced imagery, imaginal worlds, and visual memories from the past (Watkins & Watkins, 1986). It may be interesting that the latencies required for the shifts in d.c. potentials during satiation (Hallschmid et al., 2003) and for different proportions of alpha activity to emerge over the left and right temporal lobes during continuous application of weak complex magnetic fields (Persinger, 1999) are also within the range of about 5 min.

The results from the present experiments are consistent with the conditions and details associated with the historical and scientific literature concerning sensed presences. They are easily evoked phenomena that are strongly associated with right hemispheric activity. The experiences are correlated with increases in global (and hence local) geomagnetic activity. A specific rate of change within the east–west vector of the geomagnetic field may be a facilitator. Perhaps most importantly, the sensed presence can be both studied and generated within experimental settings. Their amenability to experimental manipulation, the most decisive component of the scentific method, may allow the complete explanation for their origins.

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